



Channel Islands National Marine Sanctuary

2005 Research Summary



The Channel Islands National Marine Sanctuary (CINMS or sanctuary) partners with government agencies, academic institutions, private research institutes and non-profit organizations to conduct research in the sanctuary and surrounding areas. CINMS provides approximately 140 days annually of at-sea research support with its 62 foot *R/V Shearwater*. A smaller vessel, *R/V Xantu*, and a seaplane are also used to support research. Following is a summary of CINMS research activities in 2005 which included seabird research, marine reserves monitoring, habitat mapping, water quality studies, unmanned aerial vehicle research and an oil seeps study.

SEABIRDS

Ashy storm-petrels

In 2005, researchers Bill McIver (US Fish and Wildlife Service) and Harry Carter (Carter Biological Consulting, Victoria, B.C., Canada) continued long-term monitoring of Ashy Storm-Petrels nesting activities in sea caves at Santa Cruz Island. The Ashy Storm-Petrel (*Oceanodroma homochroa*) is a rare seabird (~10,000 worldwide) which breeds on islands and offshore rocks off the coast of California. Population declines at major breeding colonies on the Farallon Islands and Channel Islands due to predation, pollutants, human disturbance, and low breeding success are of concern to resource managers and the species is classified as a California state species of special concern. Approximately half of the entire population of this rare storm-petrel species is found at the Channel Islands.

McIver and Carter visited study sites throughout the summer and fall of 2005 and monitored nests according to standardized data collection methods, which have been used each year from 1995-2005. Researchers searched for and examined nests and then mapped and marked each one with an individually numbered aluminum tag. All potential nesting habitat was searched in caves

and on Orizaba Rock until October, after which only marked nests were examined. Researchers monitored all marked nests on subsequent visits, except when tags could not be relocated. Observed numbers of birds, eggs and chicks were recorded for each nest site. Because storm-petrels are sensitive to disturbance at nest sites (Ainley et al. 1990), the adults, incubated eggs, or brooded chicks were not handled. The ages of chicks were estimated and chicks with large enough legs were banded.



Ashy Storm-Petrel chick and adult

At five sites a total of 87 nests were located and 16 chicks were banded. However, Island Spotted Skunks repeatedly predated one site which resulted in total reproductive failure at that site and the death of most of the sites' breeding population.

The number of active nests of Ashy Storm-Petrels at three of the sites were consistent with numbers of active nests reported in 1995-97, whereas at a fourth site, Orizaba Rock, a site that has seen declines in nests during previous studies, active nests were lower in 2005 than in 1995-97 (McIver 2002). Reasons for this decline are poorly understood but may reflect heightened predation by gulls or owls related to colony illumination from lights of squid-fishing boats (Carter et al., in review).

This research continued the development and implementation of a long-term monitoring program for Ashy Storm-Petrels and these results suggest that management actions are needed to

protect this species on island colonies (e.g., human disturbance, habitat destruction, predators) and in at-sea foraging areas (e.g., oil pollution, chemical pollution [DDT], lights from squid-fishing and other boats; at-sea weapons testing). Monitoring will continue in 2006 and is needed to assess population trends and reasons for any declining trends. Financial support was provided by the California Department of Fish and Game (CDFG). Vessel support was provided by the sanctuary and by the Channel Islands National Park (CINP).

Xantus's Murrelets

Seabird biologists Darrell Whitworth and Josh Koepke of the California Institute of Environmental Studies completed the sixth year of Xantus's Murrelet nest monitoring on Anacapa Island in 2005. Anacapa is one of only 12 islands where Xantus's Murrelets (*Synthliboramphus hypoleucus*), a California state threatened species, are known to breed, and the survival of this important colony had been threatened by predatory non-native Black Rats (*Rattus rattus*). The eradication of rats (completed in 2002) was a key element of the Anacapa Island Restoration Program, a project sponsored by the *American Trader* Trustee Council with support from CINMS and CINP. The study documents the population status before (2000-02) and after (2003-05) predator removal.



A Xantus's Murrelet nesting in a crevice

In collaboration with CINMS and CINP, Whitworth and Koepke continued studies to measure nesting effort and breeding success in

2005. *R/V Shearwater* and *R/V Xantu* were used for bi-weekly monitoring throughout the birds' breeding season (March-July). Channel Islands Naturalist Corps volunteers were enthusiastic participants in the research. The murrelets' nesting habitats (nests are hidden in small crevices in steep, rocky cliffs or sea caves) made these studies quite challenging, but the researchers' efforts have demonstrated the benefits of removing rats from Anacapa Island. Despite late nesting, the number of active murrelet nests and hatching success were higher than in any year since monitoring began, with 88% of the 26 total nests hatching in 2005. Furthermore, the colony appears to be expanding into areas previously occupied by rats, with five nests observed on the cliffs in Landing Cove in 2005, where none were known prior to 2003.

Overall, the number of murrelet nests found increased 81% in 2003-05, compared to 2000-02. Most notably, no murrelet nests have been destroyed by rats since 2002, while over half (52%) of all nests found in 2000-02 were taken by rats. Rat eradication has greatly improved the prospects for survival of this colony, but ongoing monitoring will be needed to document the continued recovery of Xantus's Murrelet at Anacapa Island.

MARINE RESERVES MONITORING

Delta Submersible

As part of reserves monitoring efforts to characterize habitat, UCSB researcher Dr. Milton Love, along with Donna Schroeder, Merit McCrea and Linda Snook made 28 research dives in 2005 using the *Delta* research submersible in sanctuary waters. The research goals during these dives were 1) to compare fish surveys made with a submersible to those made by an ROV operated by the California Department of Fish and Game (CDFG) and others; 2) to conduct baseline surveys at current and projected marine protected areas; 3) to continue research on black corals, sponges and other habitat forming invertebrates

Dives were made in the Gull Island area, along the south side of Santa Cruz Island, at the Footprint Ridge, Piggy Bank, in the Santa Cruz-Anacapa Island Passage, and on the north side of



Cowcod seen from Delta submersible

Anacapa Island. For the submersible-ROV comparisons, surveys were conducted in the marine protected areas on the north side of Anacapa Island and off Gull Island. The surveys were made along the same tracks as CDFG ROV surveys that had been made a few weeks previous.

Baseline surveys were made at the Footprint Ridge and Piggy Banks; both have been nominated as federal marine protected area sites. Dr. Love and his team have surveyed these rocky areas for the past few years and have found that they contain excellent habitat but harbor relatively few large fishes, which researchers suggest may be a result of historic overfishing.



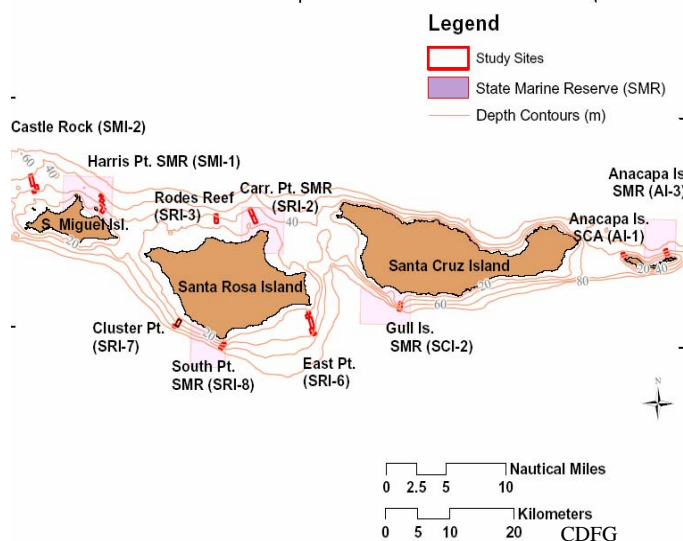
Basket star seen from Delta submersible

Researchers also collected and surveyed the newly described deep-water black coral, *Antipathes*

dendrochristos, the Christmas Tree Coral. This coral is relatively abundant on the Footprint and the surveys are designed to help understand what habitats this species occupies and whether the coral, and other large invertebrates such as sponges, form habitat for fishes. This year researchers collected several small colonies of coral for ageing studies to determine if this species, like other deep water corals, is long-lived.

Remotely Operated Vehicle

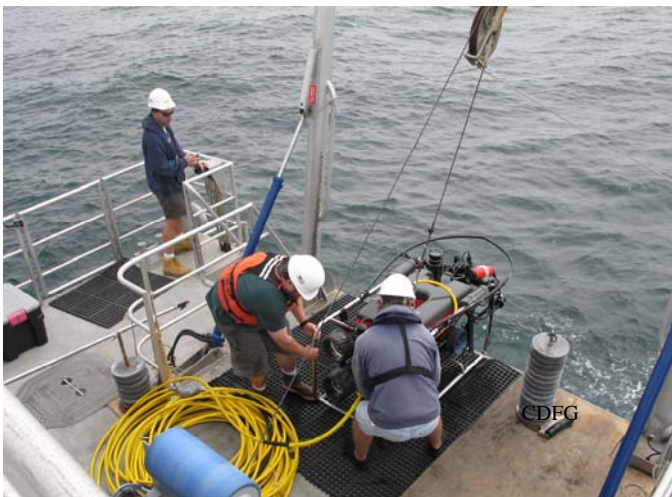
California Department of Fish and Game, in partnership with the sanctuary, the Nature Conservancy, and Marine Applied Research and Exploration, used a remotely operated vehicle (ROV) to survey fish populations. 2005 was the third consecutive year of this project. The objective of this research was to monitor changes in finfish density on hard bottom reefs that are beyond depth limits of SCUBA divers. This work is designed to provide data for the evaluation of the Channel Islands Marine Protected Areas (MPAs) as described in the Channel Islands Marine Protected Areas Monitoring Plan (www.dfg.ca.gov/mrd/channel_islands/monitoring).



ROV survey sites are shown in red

The survey was expanded to ten sites in 2005, of which five were in MPAs and five were adjacent to MPAs, on four different islands. In August 2005 the CDFG *P/B Swordfish* was used to quantitatively sample two sites, one near Anacapa

Island and one near Santa Rosa Island, as well as to explore two sites near San Miguel Island. In September and October 2005, the sanctuary's *R/V Shearwater* was used to complete the survey of eight more sites, including the two sites on San Miguel Island, and also to videotape fish models on the seafloor to evaluate potential for measurements of fish size. Data from 2003 and 2004 showed that at most sites hard bottom habitat is patchy; therefore, to more effectively sample the sites, efforts focused on hard bottom areas and excluded some areas of other habitat types from sampling. In general, sampling sites are rectangles 500 m wide spanning a depth range from 20 to 70 m.



Researchers deploy ROV from *R/V Shearwater*

Highlights of the video included videotaping a sea lion interacting with a five gill shark (*Hexanchus griseus*), nine Giant Black Seabass (*Stereolepis gigas*) seen in one day near Anacapa Island (normally this is an uncommon species), and the incredible high relief habitat near San Miguel Island. Over 200 hours of video covering 110 km was collected: enough to assure that the researchers met their target sample size of 75 100m² transects at each site. This data will be compared to the Delta submersible fish surveys conducted by Dr. Milton Love's team. If the data are found to be comparable, the two methods can be used to cover a broader survey area. In addition, the ROV recorded derelict fishing gear that CDFG, the sanctuary, and marine debris removal groups are working to remove. For more information on ROV sampling protocols and research cruises, see the CDFG web site (www.dfg.ca.gov/mrd).

Kelp Forest Monitoring

In collaboration with CDFG, CINMS, National Marine Fisheries Service, and others, CINP biologist David Kushner lead a team of scientists in monitoring important components of the kelp forest ecosystem. 2005 marked the 24th year of CINP's long-term Kelp Forest Monitoring Program (KFMP). In addition to the seventeen kelp forest sites that have been previously monitored, the researchers essentially doubled the study size by establishing sixteen new sites in 2005. These new sites were paired up with eight of the original sites to collect baseline data from inside and adjacent to four of the newly established MPAs and these pairings will later be used for the evaluation of MPA effectiveness.

Divers on SCUBA and surface-supplied-air used standardized techniques to count species along transects and in quadrats, as well as using other survey techniques. Population dynamics of over 68 taxa, or categories, of algae, fish and invertebrates were studied and temperature was logged at each site. This monitoring effort required 71 days aboard the research vessels *Pacific Ranger* (CINP), *Garibaldi* (CDFG) and *R/V Shearwater* (CINMS) and 1,177 dives with a total bottom time equivalent to 45 days.

Since data collection on this project began in 1982, there have been notable widespread and dramatic changes to the marine communities and populations within Channel Islands National Park and sanctuary in recent years. These changes, a result of both man-made (fishing) and natural perturbations, have been documented by the KFMP (Rodgers-Bennet et al. 2002, Schroeter et al. 2001). The data collected by the monitoring program provides a long-term fishery independent data set for the Channel Islands and it has been instrumental in fishery management actions.

PISCO

In 2005, PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) continued ongoing research that began in 1999 in

the sanctuary. This program is a substantial contributor to the marine reserves monitoring effort, which seeks to characterize changes in the ecosystem as a result of marine reserves implementation.

Within the CINMS, PISCO scientists Jenn Caselle and Mark Readdie led a team of researchers conducting research in three broad but complementary areas. First are studies of nearshore ocean circulation. These studies employ a suite of advanced oceanographic tools, including Acoustic Doppler Current Profilers (ADCPs), coastal radar (CODAR), satellite imagery, surface chlorophyll estimation, and physical sensors mounted on moorings. In 2005, the sanctuary augmented PISCO's array of physical sensors with the purchase of several new ADCPs. In partnership with the sanctuary, PISCO scientists maintain these instruments and the data are shared among groups.



PISCO scientist retrieves larval collector

Secondly, PISCO scientists continued a large-scale, long-term study of the patterns of community structure on shallow subtidal, rocky reefs. Ultimately, the goal is to understand and predict how environmental change (including human impacts and management strategies such as MPAs) influences these physical and ecological processes

and how communities respond to such changes. In 2005 the number of monitoring sites was increased to 34 within the sanctuary boundaries. These sites are located both inside and outside of the MPAs and span the variation in water temperature across the sanctuary

Finally, a last project led by Dr. Caselle is a long-term, sanctuary-wide monitoring study to examine temporal and spatial patterns in recruitment of fishes and invertebrates and the factors responsible for these patterns. This research employs artificial collectors called SMURFs (Standardized Monitoring Units for Recruitment of Fishes). To date, this research has shown very strong interannual patterns in reef fish recruitment. Previous results showed that years of very strong recruitment for the rockfishes (*Sebastes* spp) tend to be years of low recruitment for kelp bass (*Paralabrax clathratus*). 2005, while a year of moderate recruitment of kelp bass and one group of rockfishes (kelp, gopher, copper) was a year of very low recruitment of another rockfish group (olive, yellowtail, black). In 2005, PISCO scientists took three summer cruises on *R/V Shearwater*. For more information on PISCO see <http://www.piscoweb.org/research>

Rocky Intertidal Monitoring

National Park Service monitoring of the Channel Islands rocky intertidal ecosystem began in 1982 at Anacapa Island and has continued through 2005, now including 21 sites on the five islands in the Park and sanctuary. Information from this project is used to determine intertidal community changes and to provide a baseline for evaluating future population shifts.

In January 2005, researchers used *R/V Shearwater* to visit monitoring sites at Frenchy's Cove, Cat Rock, Middle Anacapa East, Middle Anacapa West, and Scorpion Rock. Other sites were monitored through the year using National Park Service, Island Packers, and the Santa Barbara Channel Keeper vessels for transportation to the islands.

CINP researcher Dan Richards leads a team of scientists who measure cover of approximately 32 target sessile invertebrates and algal taxa in fixed

plots that are photographed and scored each spring and fall. Various snail, chiton, and limpet species are monitored in those plots once a year with counts and size measurements. Black abalone and giant owl limpets are also monitored in larger fixed plots. Seastars are monitored through timed searches and surfgrass cover is monitored in fixed transects. Abundance of key hole limpets, previously seen to be declining, appeared to be stabilizing in 2005 and recruitment of new individuals was observed at some sites where they were not observed in recent years.

In addition to the monitoring, in 2005, researchers combined many of the rocky intertidal trips with beach monitoring to collect baseline numbers of carcasses on beaches that would be available to reintroduced bald eagles. Another added feature of their program was bringing students, parents and teachers to Anacapa Island to experience the tidepools there.

This project involves collaboration with many other researchers from UCSB, UCSC, Santa Barbara Channel Keepers and CINMS and, in 2005, a Student Conservation Association intern joined the group to catalog and to manage the thousands of photos taken during these research trips.

REEF

A team of Reef Environmental Education Foundation (REEF) expert surveyors continued annual targeted monitoring of the nearshore marine reserves around the CINMS in February 2005. REEF is an international marine conservation non-profit organization supporting hands-on grassroots activities designed to educate and engage local communities in conservation-focused activities. As part of REEF's Fish Survey Project, visual fish surveys are conducted on SCUBA throughout the sanctuary every year.

The field plan is designed to assist in evaluation of reserves, with locations inside reserves and reference sites at comparable locations outside reserves. The project includes 30 sites; seven sites on San Miguel, eight sites on Santa Rosa, eight sites on Santa Cruz, and seven sites on Santa Barbara Island. REEF surveys follow the Roving Diver Technique (as described in Schmitt and Sullivan, 1996, Bulletin of Marine Science).

Each diver records all fish that can be positively identified during their dive. The species information, along with metadata associated with the survey, is transferred to a REEF survey scansheet. The resulting data are optically scanned into REEF's database. During the February 2005 cruise seven sites were visited and sixteen REEF surveys were conducted documenting a total of 38 fish species.



Carl Gwinn

A REEF diver records fish seen among the kelp

In addition to the data collected during *R/V Shearwater* cruise, REEF volunteers conducted an additional 59 surveys in CINMS in 2005 during their regular sport diving activities. As part of this program, volunteer sport divers conduct REEF surveys anytime and anywhere they are diving. To date, a total of 1,444 REEF surveys have been conducted in CINMS, documenting 122 species of fish. For more information, including trip reports and data summaries, visit <http://www.reef.org>

PIER

Researchers James Lindholm and Michael Domeier of the Pflieger Institute of Environmental Research (PIER) conducted quarterly cruises throughout 2005 on board PIER's *R/V Malalo* in collaboration with researchers from UCSB and Cal State University Long Beach. Their research uses an array of acoustic receivers to quantify the movement behavior of coastal fishes in the Channel Islands and the Southern California Bight. This research aims to determine spatial distribution and movement of fishes in the sanctuary.



A tagged Sheephead is released

Individuals of target fish species are captured, inserted with an acoustic tag and released back into the water. The tags transmit a signal to the receivers and researchers monitor how closely associated fish are with a home territory and how much they move between islands, between the island and mainland, and among the boundaries of the MPAs. There are over one hundred acoustic receivers around the islands within CINMS, as well as sites at Santa Catalina Island and the mainland.

In 2005, data on more than 200 individual fish were collected completing the fifth consecutive year of data collection on acoustically-tagged giant sea bass (*Stereolepis gigas*), the second year for white sea bass (*Atractoscion nobilis*), and the first year for California sheephead (*Semicossyphus pulcher*) and kelp bass (*Paralabrax clathratus*). For more information visit the PIER website: <http://www.pier.org/>

Aquarium of the Pacific

During a five day cruise in December 2005, Ed Cassano of the Aquarium of the Pacific (AoP) and Scott Hamilton of UCSB lead a team of researchers and volunteers on board *R/V Shearwater* to test research protocols under development for AoP's Community-based Collaborative Marine Conservation Program. The ultimate goal of the program is to involve scientific diver volunteers from AoP in a three-year research project evaluating the efficacy of MPAs within the sanctuary.

Divers conducted day and nighttime dives at sites inside and outside of MPAs at three of the Channel Islands to assess the effectiveness and design of specific research protocols. Techniques for measuring densities and population size structure of sea urchins and sea stars were evaluated and, during night dives, video and visual estimation techniques to assess size structures and densities of lobsters and crabs were tested. To characterize habitats, benthic invertebrates, and small sedentary fishes divers used a video camera mounted in a special camera frame to record one-meter-wide swaths of the seafloor. Finally, the team pioneered the use of a baited underwater video station to assess the abundance of fishes whose behavior may be affected by the presence of underwater observers. Each protocol was tested by multiple divers at several sites during the day and night and modifications were made to the techniques for future studies. Additionally, they attempted to locate suitable sites for future long-term research.

Using experience gained from this pilot study, researchers were successful at implementing and improving the design of the research protocols and look forward to expanding this project in 2006. For more information, visit the Aquarium of the Pacific website:

<http://www.aquariumofpacific.org/index.html>

SAMSAP

Since 1997, the Sanctuary Aerial Monitoring Spatial Analysis Program (SAMSAP) has monitored and analyzed physical and anthropogenic phenomena in the sanctuary, including commercial and recreational vessel traffic, effects of shore

runoff, oil spills, and biological data on marine mammals and giant kelp. Mapping the distribution of vessels in the sanctuary helps identify patterns of resource use while the aerial perspective provides a large scale view for biological monitoring. SAMSAP data provides a baseline to analyze MPA effects, as the program was initiated prior to MPA establishment.



CINMS' aircraft flies near Anacapa Island

A sanctuary pilot and scientist regularly fly a Lake Renegade Seawolf aircraft. In 2005, they flew 122.8 hours. During these flights, aerial observations of vessel traffic were made to assist in the study of anthropogenic use patterns. Vessels observed were categorized based on the type of activity: commercial or recreational. Commercial vessels included urchin boats, trawlers, gill netters, lobster boats, and freighters. Recreational vessels included recreational fishing boats, sailboats, and kayaks.

Mapping the locations of recreational vessels versus commercial vessels revealed a distinct spatial divergence. The majority of recreational vessels were concentrated in the eastern portion of the sanctuary, particularly around Santa Barbara, Anacapa, and Santa Cruz Islands while vessels in the western portion of the sanctuary consisted mostly of commercial fishing activity. The majority of commercial and recreational vessels were in close proximity to the islands. This information on use patterns will assist the sanctuary in examining potential vessel displacement from state MPAs which may indicate fishing is concentrated in a smaller area, with potential effects to the ecosystem.

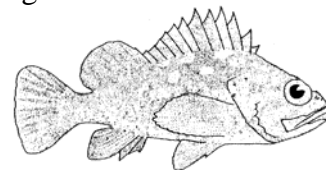
Rockfish Recruitment Surveys

Donna Schroeder of the Marine Science Institute at UCSB, with a crew of staff and volunteers, conducted two fish surveys in CINMS in the summer of 2005. Both projects contribute to the reserves monitoring program and aim to understand fish communities in the sanctuary.

In early July 2005, researchers were on board *R/V Shearwater* for five days of surveys at Santa Rosa Island. The goal of this trip was to compare species composition, size structure, and density of fish assemblages inside and outside of MPAs in CINMS in order to assess MPA effectiveness. Differences seen between protected and non protected areas, or changes seen in protected areas since the reserves were created, will give an indication of the effects that the reserves are having on the ecosystem.

In late July 2005, Schroeder and crew spent five days at Santa Cruz and Anacapa Islands studying young rockfish. Rockfish are a recreationally and commercially fished species that have seen population declines along the coast of California in recent decades. Studying their distribution and strength of recruitment success is a critical part of understanding population status and trends. The purpose of this trip was to determine, first, the species composition, density and size structure of juvenile rockfishes in CINMS which may help scientists understand rates of juvenile recruitment and population recovery time of overfished rockfish species. The second objective was to compare water quality and contaminant load of fishes inside and outside CINMS.

These objectives were accomplished by divers swimming 30 meter transects just beneath the kelp canopy where young rockfish aggregate. Rockfish were enumerated and percent kelp canopy cover was recorded. Secondly, divers captured a sample of rockfish recruits for otolith (earbone) microchemistry analysis. The chemical signatures in these structures may reveal information about the geographic origin of the larvae and contamination.



Gopher rockfish

HABITAT MAPPING

Side-Scan Sonar

In August 2005, U.S. Geological Survey (USGS) personnel surveyed approximately 75 km² of the continental shelf southeast of Santa Barbara, using sonar to collect information about the sea floor. The researchers, led by Dr. Guy Cochran, used interferometric sonar which collects both bathymetric (depth measurements) and acoustic-backscatter data, which yields information about the sea-floor surface similar to side-scan sonar data, allowing researchers to distinguish, for example, between areas of soft mud and hard rock and to image manmade structures, such as pipelines. The survey was funded by Minerals Management Service (MMS) and was supported by *R/V Shearwater*.

The final three days of the cruise were spent collecting video footage in selected areas to groundtruth each type of pattern observed in the sonar data—smooth, featureless images that might indicate a muddy bottom, for example, or sharp contrasts that might indicate rocky habitat. Rocky sea floor was mapped north of oil platforms in Santa Barbara Channel along an east-west-trending bathymetric ridge. This type of sea floor supports diverse communities of marine organisms, including rockfish, an important resource for commercial and recreational fisheries.

Good weather and reliable equipment gave researchers the opportunity to collect additional data southeast of Carpinteria for a USGS coastal-erosion study being conducted in cooperation with the city of Carpinteria and the U.S. Army Corps of Engineers. That study will eventually include bathymetric surveys in nearshore waters and the surf zone, high-resolution mapping of the beach, and deployment of offshore instruments to measure waves and sediment transport. Data generated from this work will be used for various purposes, including monitoring oil and gas activity, assessing biological resources, locating natural tar seeps, and monitoring archeological resources. For more information, visit <http://soundwaves.usgs.gov/2005/10/fieldwork2.html>

WATER QUALITY

Plumes and Blooms

The Plumes and Blooms (PnB) program of the Institute for Computational Earth System Science at UCSB completed its ninth consecutive year of optical data collection in 2005. The main goal of the PnB Project is to develop and optimize algorithms that will be used to relate measurements taken from satellites to in situ ocean properties like chlorophyll content and organic and inorganic particles.



Researchers retrieve water from sampling rosette

Plumes and Blooms cruises were conducted onboard *R/V Shearwater* approximately once every three weeks in support of a NASA grant entitled 'Rigorous application of MODIS Ocean Color Imagery to a Case II Ocean: Case Study of Plumes and Blooms in the Santa Barbara Channel'. Data are collected along a seven-station transect from Santa Rosa platform to Goleta Point. Each PnB cruise measures physical characteristics of the water including parameters that describe color and light in the water as well as temperature, pressure, and density, among many others. Samples help determine if characteristics of the water originate from land, as in sediment washed down in rivers ("plumes") or from phytoplankton, tiny plant-like organisms in the sea ("blooms"). Optical profiling instruments, sensors and water sampling bottles are attached to a metal frame (the rosette) and deployed to a depth of 200 meters. After recovery of the rosette, an instrument is deployed to measure qualities of light reflected from the water. The

ship's electronic laboratory is used to send commands to the instruments and receive data in real-time through an electro-mechanical cable. The novelty this year has been initiation of aerosol optical thickness observations along with the traditional PnB sampling program to assess the influence of the amount of aerosols on ocean color modeling.

In 2005, the PnB data set was analyzed to investigate how well ocean color can be determined from in-water constituents and what optical properties are important for modeling ocean color variability in the Santa Barbara Channel. The Santa Barbara Channel is a highly productive region of the California Current System and chlorophyll concentrations are consistently higher than typical oceanic values. The performance of existing ocean color algorithms was evaluated using the PnB data set. The algorithms performance proved to be satisfactory but not excellent. The optical complexity of the Santa Barbara Channel coastal waters suggests that regionally specific models should be developed to best account for independently varying optical constituents. The PnB data set has been extensively used in papers and publications and has enabled several graduate students to complete advanced degrees. For more information about this project visit the Plumes and Blooms web site:

<http://www.icess.ucsb.edu/PnB/PnB.html>.

OTHER PROJECTS

UAV

NOAA and NASA conducted the Altair Integrated System Flight Demonstration Project in cooperation with General Atomics Aeronautical Systems, Inc. (GA-ASI) from April to November 2005. Altair is a high-altitude long-endurance (HALE) UAV platform built and operated by GA-ASI. The goal of this project was to evaluate unmanned aerial vehicles (UAVs) for future science and operational requirements within the agencies, related to oceanic and atmospheric research, climate research, marine sanctuary mapping and enforcement, nautical charting, and fisheries assessment and enforcement.



Altair in flight along the coast

The flight objectives of this multi-agency project included sampling low-level atmospheric jets in the eastern Pacific Ocean that bring moisture to the continental US; sampling regions of high potential vorticity (ability to form a vortex) at mid-latitudes that result from transport of polar air; and imaging of CINMS to examine shorelines and evaluate the potential for marine enforcement surveillance.

The Altair payload included remote and in situ instruments for measurements of ocean color, atmospheric composition, and temperature; and a surface imaging system. In situ composition measurements included ozone and long-lived gases such as halocarbons and nitrous oxide. The vertical distribution of water vapor was remotely measured with passive microwave sensors. Five flights were completed, for a total of 45.3 flight hours plus 20.6 on integration flights. Flights reached altitudes of 45,000 ft and the longest duration flight was 18.4 hours. For more information, visit:

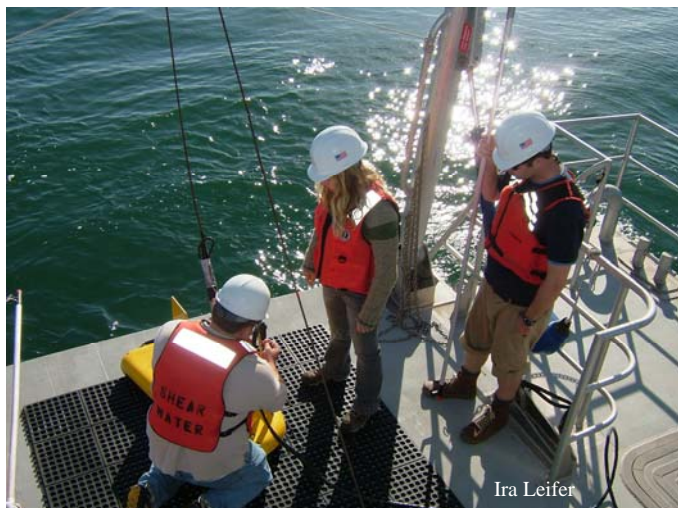
<http://uav.noaa.gov/>

Oil Seeps

In April 2005 UCSB scientist Dr. Ira Leifer was chief scientist on board *R/V Shearwater* to conduct surveys of the Coal Oil Point seep field. Marine seeps naturally produce a continuous emission of gas or oil, both as droplets and as oily covered bubbles. Recent estimates indicate that natural gas seepage from the sea bed could play an important role in increased atmospheric concentration of the greenhouse gas methane, CH₄, and may affect the local oceanic environment.

Seeps are also home to numerous living creatures including bacteria, tube worms, mussels and fish. This mapping project seeks to relate the locations of sea bed and sea surface seepage with geological factors to better understand the sources and migration of hydrocarbons from the seabed to the Santa Barbara Channel. Project goals include looking at temporal and spatial variations in the seep field, the fate of gas and oil and tar released at the seabed, and the relationship to faunal distributions.

Leifer's team identified and sampled oil seeps on the surface along the Santa Barbara coastline. The researchers collected fresh surfacing oil samples for geochemical fingerprinting. Significant and extensive slicks, extending over an area of many kilometers, were observed in the area of the seeps and video images were taken to analyze the slick extent. In addition, sonar was used to locate and map seeps on the seafloor. Sonar surveys began in the deepest seeps to the southeast of La Goleta Seeps in 80 - 100 m of water depth. This patch of seepage revealed an expansion from a few hundred square meters on the sea surface seen in 1995 - 1999 to more than a square kilometer seen in 2005.



Researchers deploy a sonar mapping device

circular track lines were surveyed around Platform Holly's perimeter but only minor seepage west of the platform was observed.

The planned sonar surveys, which were at a higher spatial resolution and covered a larger area than previous surveys, were completed during the cruise. Other measurements were taken at the surface, including wind, direction, temperature, and gas chromatography - flame ion detection which, when analyzed in combination, allows determination of the methane fluxes above the seep field. For more information visit: <http://www.bubbleology.com/>

Furthermore, researchers discovered that seepage extends into deeper water (to 120 m) at least several hundred meters further to the south than previously known. Sonar surveys proceeded with long survey tracks stretching from the Goleta Seeps (south of UCSB) to ~ 1 km west of the oil platform Holly (~ 7 km in length). In addition,

These 16 research projects demonstrate CINMS commitment to partnering with researchers and supporting a of variety projects, from seabirds to oil seeps. To learn more about CINMS research program, please visit:
<http://www.cinms.nos.noaa.gov/res/main.html>

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